Towards sustainability practices deployment in building construction projects in Nigeria

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Received 17 April 2019
Revised 29 September 2019
21 April 2020
Accepted 27 April 2020

Abstract

Purpose – With recent extreme weather change from global warming, the ever-increasing volume of waste, and the unsustainable use of natural resources, there is the need to evolve a new way by which building construction projects are constructed to reduce carbon emissions, environmental degradation and excessive resource consumption. It is based on this premise that this paper presents the level of implementation of sustainability practices during building construction projects in Nigeria.

Design/methodology/approach – This study adopted the mixed methods research approach that involves collecting quantitative and qualitative data through the use of questionnaire and interviews. The numeric data were analysed using descriptive and inferential statistics such average percentages, mean item score, Kruskal–Wallis and Mann–Whitney *U* tests whereas the textual data were analysed thematically.

Findings – From the questionnaire survey, the result shows that the awareness level of sustainability practices by construction professionals is high in the study area. Also, the findings indicate that "choosing the right construction method for resource conservation and consideration of the client's satisfaction" is the major sustainability practices that construction professionals implement in the construction phase of building projects in the study area. Insights from the interviews align with the findings from the questionnaire survey.

Originality/value – This study concluded that the awareness level of sustainability practices is high in the study area and "choosing the right construction method for resource conservation" and "consideration of the client's satisfaction" are the major sustainability practices that construction professionals are aware of and is being implemented in the study area. Based on these findings and conclusions reached, it is recommended that construction professionals should improve their knowledge of sustainability to enhance their competence for the effective implementation of sustainability practices during building construction projects in Nigeria.

Keywords Building, Construction, Projects, Sustainability, Nigeria

Paper type Research paper

1. Introduction

The need to protect the built environment in the face of infrastructural development has been the objective of many nations, regardless of their economy (Lafarge, 2015). This is mainly as a result of public awareness in the use of natural resources, which has made sustainable development an important concept of the 21st century (Abolore, 2012). As such, sustainability in all areas of human endeavours is popular in many sectors of the economy (Okoye and Okolie, 2013). The contribution of the construction industry to human development with appropriate provision of infrastructure, which invariably improves the quality of life cannot be over-

The authors acknowledge I.W. Isang of the Department of Building in the Faculty of Environmental Studies at the University of Uyo, Uyo, Nigeria for collecting the data used in the study.

Smart and Sustainable Built Environment

2046-6099
DOI 10.1108/SASBE-04-2019-0053

emphasized (Dania *et al.*, 2013). Also, construction activities have significantly contributed to environmental degradation of the built environment as it is responsible for about half of all carbon emissions, one-third of landfill waste and consumes about one-eighth of total raw materials (Willetts *et al.*, 2010). The above data demonstrates the reason why the construction industry must embrace sustainability (Shen *et al.*, 2001; Presley and Meade, 2010) because already there are global concerns and agenda for sustainable construction with a special focus to Africa (Du Plessis, 2005). Consequently, the activities of the construction industry have to demonstrate the willingness of the industry to protect and sustain the environment. Although, there is evidence within the body of literature that buildings are being designed to adapt to the concept of sustainability (Demir and Salgin, 2019; Gültekin and Alparslan, 2011) basically to protect and sustain the environment. What is yet unclear, especially in the developing world, is the physical manifestation of sustainability during the actual construction.

Sustainable construction is defined by Kibert (1994) as "the creation and responsible management of a healthy built environment based on prudent use of resources and ecological principles". Abolore (2012) sees sustainability in construction as sustainable practices regarding the design approach/philosophy, choice of materials including construction methods in a way to improve performance and consequently reduce any form of the environmental burden that may result from the project. Numerous studies (Zolfani *et al.*, 2018; Saieg *et al.*, 2018; Banihashemi *et al.*, 2017; Lafarge, 2015; Olonade, 2015; Shen *et al.*, 2001) have provided empirical evidence to support the notion that construction activities adversely affect the environment. This is based on the fact that during the construction activities, large quantities of natural resources are consumed, water is used up extensively, much waste is generated, greenhouse gases are emitted and a wide range of ecosystem is destroyed. Further inferences from those studies reveal that the built environment accounts for an enormous amount of energy consumption and carbon emissions across its lifecycle. The reason, according to Hussin *et al.* (2013) is that the traditional practices of construction process and management were found to be unable to tame the tide of unprecedented challenges of carbon emissions that have immensely added to the global warming and extreme weather change around the world. Additionally, construction projects are conceived, designed, constructed, operated and managed with little or no evaluation from the standpoint of sustainability, especially in developing countries.

Abolore (2012) lamented that despite the concerted efforts to increase the awareness of sustainability, Nigeria is still trailing regarding the implementation of sustainable construction (Dania *et al.*, 2013). Unless drastic efforts are made to counter the negative aspect of executing construction works traditionally without any consideration for the environment, more harm than goodwill continue to come from the quest for infrastructural development (Abolore, 2012; Olonade, 2015). As such, the construction industry has to make emphatic efforts to change its ways of operation and take environmental concerns at the epicentre of their activities. While at the moment, there is no specific legal framework guiding sustainable construction in Nigeria, it is important to mention that Nigeria is one of the signatories to many prominent sustainability accords in the world (for example, the Paris Agreement and the Sustainable Development Goals). Consequently, to the best of authors' knowledge and awareness, only a few studies have attempted to look into the issue of sustainability in the Nigerian construction industry. Amongst those studies are the works of Abolore (2012); Dania *et al.* (2013); Olonade (2015); Oladokun *et al.* (2017) and Oladokun and Aigbavboa (2018). In other words, there is limited empirical and well-designed scientific inquiry known to the authors regarding the level of implementation of sustainability during construction projects in Nigeria. Therefore, the study being reported in this paper examines the level of awareness of construction professionals on sustainability practices and investigates the level of sustainability practices implementation during the construction phase of building projects in Nigeria.

2. An overview of sustainable construction practice

The concept of sustainability and sustainable construction may seem to be a new concept within the built environment research, the reality however, is that the concept is not new as it has been used in many countries (Salgın *et al.*, 2017). As such, many researchers within the construction research have described sustainable construction. For example, Al-Yami and Price (2006) described it as an application of sustainable development within the construction industry. That is when the concept of sustainable development is applied to the construction of buildings and infrastructure in terms of resources consumption and depletion (Hussin *et al.*, 2013), and the aftermath of construction activities in the form of environmental degradation are controlled. Dania *et al.* (2013) see sustainable construction as a concept that has generated high-level debates and interpretations amongst academics. Amongst the debates is the view of Hill and Bowen (1997) who report sustainable construction as the responsibility of the construction industry towards attaining sustainable development. Their study used the four pillars of sustainability (social, economic, biophysical and technical) to explain the concept of sustainable construction. Also, Abolore (2012) argued that sustainable construction is the actual process of achieving sustainability within the construction industry. Hussin *et al.* (2013) indicated that sustainable construction means responsible construction of a healthy built environment by using resources efficiently, while at the same time applying ecological principles. Further, Olonade (2015) saw sustainable construction as the responsible supply, operation and maintenance of buildings (or any other infrastructure) that meets the needs of their owners and users over their lifespan with minimal unfavourable environmental impacts, while encouraging economic, social and cultural progress. However, Huovila and Koskela (1998) was of the view that the concept of sustainable construction is not clearly defined. In the light of this debate, the definition from Shen *et al.* (2010), which says, "sustainable construction practice refers to various methods in the process of implementing construction projects that involve less harm to the environment, increases reuse of waste in the production of construction material, benefits the society and is profitable to a company" is adopted for this study due to its comprehensiveness.

Presley and Meade (2010) highlighted sustainability practices to include, economic: project cost, profitability and client satisfaction; environmental: sustainable site, water efficiency, reduction of waste, indoor environmental quality, impact on the community and social: stakeholder participation as sustainability indicators at the project level. Ugwu *et al.* (2006) indicated that sustainability practices by contractors include, environmental: waste management for solid excavated materials and construction materials, water reuse; economic: life cycle cost, employment of labour. Shen *et al.* (2011) provided a list of indicators for project sustainability. On the economic aspect, life cycle cost/benefit/profit, financial risks were amongst the indicators. The social aspect considers the provision of employment opportunities, promotion of community development and public safety while environmental indicators include effect on land pollution, air and water quality, noise effect, waste generation and energy savings. Thivaharan (2015) identified five criteria for the implementation of sustainability practice during building construction to include: reduce/recycle/reuse of construction materials, environmental protection, energy efficiency, water efficiency and indoor environmental quality. Table 1 summarises the sustainability practices during the construction phase of building projects. As interest in sustainability increases in world-over at an alarming rate, various countries such as Finland (Huovila and Koskela, 1998), the United States of America (Landman, 1999), Malaysia (Shafii *et al.* 2006), the United Kingdom (Ochieng *et al.*, 2014) and Singapore (Thivaharan, 2015) have all implemented the concept of sustainable construction. From the above, it is evident that the perceptions of most of these researchers are from outside of Nigeria. This attests to the need to reflect local reality in Nigeria as there is the paucity of academic papers in this domain of research. As such, this paper then intends to fill this gap.

Sustainability practices	Sources	Location
Environmental sustainability Waste management for solid excavated materials and construction materials, water reuse; sustainable site, water efficiency, reduction of waste, indoor environmental quality, impact on community; effect on land pollution, air and water quality, noise effect, waste generation and energy savings; choosing the right recyclable materials after their useful life, choosing the right construction method for resource and energy efficiency, integrating heating, ventilation and air conditioning (HVAC) systems; increase material efficiency, reduce material intensity via substitution technology, enhance material recyclability, control the use and dispersion of toxic materials, consider the impact of project on air, soil and water; reducing the negative impacts of building sites (noise and dust), using renewable materials, recycling materials after demolition; reduce, recycle, reuse of construction materials; environmental protection (new technology and systems); energy and water efficiency; indoor environmental quality	Ugwu *et al.* (2006) Presley and Meade (2010) Shen *et al.* (2011) Abolore (2012) Hussin *et al.* (2013) Lafarge (2015) Thivaharan (2015)	Hong Kong United States of America Hong Kong Nigeria Malaysia Worldwide Singapore
Economic sustainability Consider life cycle cost benefit/profit, employment of labour; profitability and client satisfaction; develop economic instrument to promote sustainable consumption, consider the economic impact on local structures	Ugwu *et al.* (2006) Presley and Meade (2010) Hussin *et al.* (2013)	Hong Kong United States of America Malaysia
Social sustainability Stakeholder's participation; provision of employment opportunities, promotion of community development and public safety; enhance a participatory approach by involving stakeholders, promote public participation, assess the impact on health and the quality of life	Presley and Meade (2010) Shen *et al.* (2011) Hussin *et al.* (2013)	United States of America Hong Kong Malaysia

Table 1.
Summary of sustainability practices during construction phase of building projects

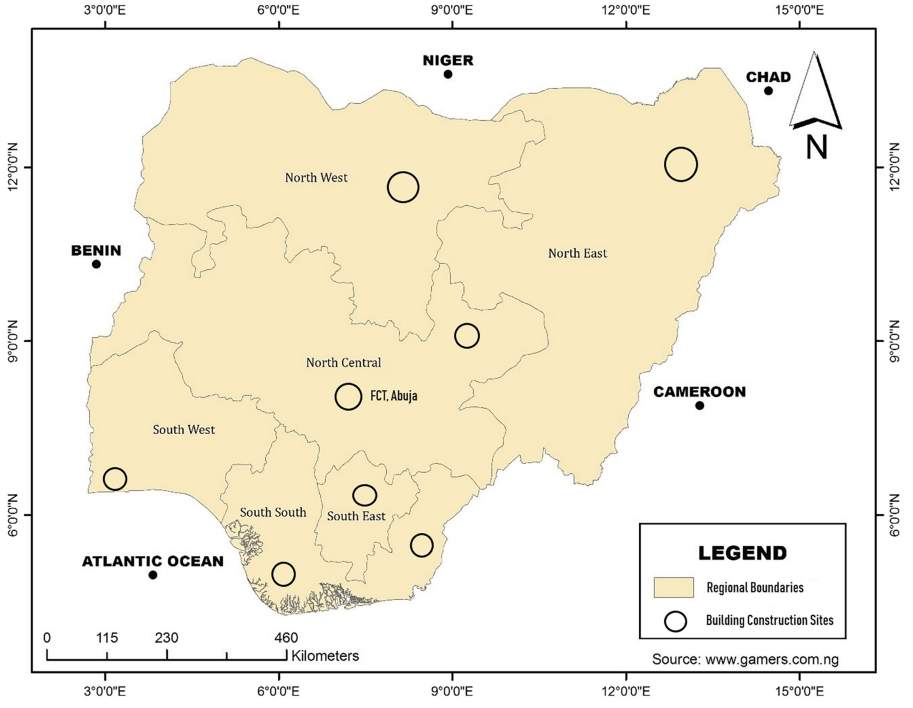
While there is little or no documented evidence to suggest that environmental sustainability of building projects, in the form of green building certification, is being implemented in Nigeria (with an exception of donor agencies projects like that of United Nations, European Union, amongst others), it is therefore imperative to investigate and ascertain the level of implementation of sustainability practices during building construction projects in Nigeria.

3. Methodology

In a bid to examine the level of awareness of construction professionals on sustainable practices and investigate the level of implementation of sustainable practices during the construction phase of building projects, variables that constitute sustainable practices were identified from the literature. The limited applicability of the identified variables is herein acknowledged. To adapt these variables to the local reality, the variables were piloted using construction professionals and academics that were adjudged to be knowledgeable in the area of sustainable construction. The pilot study involved four construction professionals (one professional each from Architecture, Building, Civil/Structural Engineer and Quantity Surveying) and four academics in the field of sustainable construction. A face-to-face interview session in the form of the focus group was conducted for the construction professionals for them to scrutinise the content of the draft questionnaire. Also, the draft questionnaire was sent to the four academics identified for the pilot study. Inputs from the construction professionals and academics improved and validated the variables included in the questionnaire and interviews protocol. In all 22 sustainable construction practices were

included in the questionnaire as variables. These variables were the basis for producing the interviews protocol.

Data for the study were collected using the questionnaire survey and interviews approaches. Purposive sampling was adopted for study to select projects and hence the construction professionals in charge of each building construction projects. Purposive sampling, which according to Cresswell and Plano Clark (2011), involves identifying and selecting individuals based on their knowledge or experience about a phenomenon under investigation was used in the study. The study identified 380 building construction sites covering the six geopolitical zones of Nigeria and the Federal Capital Territory (FCT) (Figure 1). The 380 construction sites include 50 each from the North West, North Central, North East, South East and South–South, respectively, while 75 each were allotted to the South West and FCT, Abuja mainly because of the concentration of building construction projects in the areas. It is important to let the readers know that Lagos located within the South West region of Nigeria is the commercial nerve centre of Nigeria where various building construction projects are presently ongoing, while Abuja is the FCT and the seat of power of Nigeria and as such numerous building construction projects are ongoing. Additionally, the headquarters of the majority of building construction companies are located in these two regions. For each building construction project purposively selected, the head of such a building construction site was selected to respond to the questionnaire administered, therefore making the sample size used for the study to be 380 professionals. As such, 380



Source(s): Retrieved with modification from https://www.gamers.com.ng/map-archives/ on 19/04/2020

Figure 1.
Map of Nigeria showing geographical spread of building construction sites

copies of questionnaire were administered to building professionals as explained above resulting in 80 valid responses as shown in Table 2.

The qualitative aspect was conducted by interviewing nine construction professionals consisting of three Builders, two Architects, two Engineers and two Quantity Surveyors, purposively selected based on a case study of seven building construction projects they were currently executing. One building project each was selected for each zone including the FCT in a bid to gain further insights into the issue of sustainability practices implementation on building projects. The interviews were based on a face-to-face approach except one that was conducted through telephone. The duration of the interviews ranged between 7 and 22 min.

Percentages were used to analyse the demographic variables for the study. The preliminary data analysis for the study objectives were conducted using descriptive statistics including the awareness level and mean item score (MIS) before using the inferential statistics to deduce more insights from the study. Specifically, the awareness level was computed using the frequency of responses with "Yes" against the total number of respondents. Equally, the content analysis of digitally recorded interviews was conducted by thematically analysed the transcribed recordings.

It is important to mention the purpose of the study being reported in this paper again. The study investigates the level of implementation of sustainability practices during building construction projects in Nigeria. It is equally expedient to explore the variation in the views of different respondents based on their professional affiliations. Consequently, the following hypotheses were formulated for the study:

H1. There is no significant variation in the perception of construction professionals regarding the level of awareness of sustainability practices during building construction projects in the study area.

H2. There is no significant variation in the perception of construction professionals regarding the level of implementation of sustainability practices during building construction projects in the study area.

Hypotheses were tested using the Kruskal–Wallis and Mann–Whitney U tests at 0.05 significance level. The confidence level of the hypothesis was set at 95% and the decision rule was that if the p-value is less than 0.05, it means the null hypothesis is rejected and the alternative hypothesis is accepted. Otherwise, the null hypothesis is accepted and the alternative hypothesis is rejected.

4. Results and interpretation

4.1 Respondents' characteristics and reliability of data

Table 3 presents the respondents' background in terms of the nature of building projects executed, designation/professional affiliation, academic qualification and years of work

Table 2. Questionnaire administration

Geopolitical zones in Nigeria	Number of questionnaires administered	Number of collected questionnaires
North West	50	6
North Central	50	8
North East	50	5
South West	75	25
South East	50	7
South South	50	9
FCT	75	20
Total	*380*	*80*

Respondents' characteristics	Sub-characteristics	No	%
Nature of building	Educational	21	26.25
Projects executed	Commercial	19	23.75
	Industrial	15	18.75
	Residential	25	31.25
	Total	80	100
Designation/professional affiliation	Builders	17	21.25
	Architects	13	16.25
	Engineers	28	35.00
	Quantity surveyors	22	27.50
	Total	80	100
Qualification	BSc	65	81.25
	MSc	10	12.50
	PhD	5	6.25
	Total	80	100
Work experience	0–5 years	36	45.00
	6–10 years	34	42.50
	11–15 years	6	7.50
	Above 15 years	4	5.00
	Total	80	100

Table 3. Surveyed respondents' characteristics

experience. An in-depth look at the table shows the proportion of the nature of building projects being executed by the respondents to be: residential 31.25%, educational 26.25%, commercial 23.75%, while industrial projects were 18.75% indicating that majority of building construction projects being executed in the study area were residential buildings. Table 3 also indicates that 35% of the respondents were Engineers, 27.5% Quantity Surveyors, 21.25% Builders, while Architects represented 16.25%. This result implies that the built environment professionals were the respondents in the study with Engineers being the highest head of building construction sites. Moreover, the table shows that majority of the respondents have adequate educational qualification to participate in the study with 81.25% having a BSc degree. Additionally, the table shows that the years of experience of the respondents in executing building construction projects in Nigeria. The results of this indicate that 55% of the respondents have experience of more than 5 years implying that most of the respondents have adequate knowledge and experience in building projects to make a useful contribution to this research.

Analysis of the interviews was conducted to gain more insights from the respondents on the actual implementation of sustainability practices on building construction sites. Table 4 reveals that three Builders having a combined working experience of 49 years, two Architects with 22 working years, two Engineers with 17 years of experience and two Quantity Surveyors with 21 working years in executing building construction projects were interviewed. The interviewees were contractors, consultants and clients in the public and private sectors as the case may be as shown in Table 4. This generally implies that the interviewees had adequate qualification, knowledge and experience for making useful inputs to the research.

4.2 Awareness level of sustainability practices on building construction projects

To examine the level of awareness of sustainability practices during building projects, 22 sustainability practices were identified from the literature and piloted with the construction professionals and academics. These variables were the ones included in the questionnaire and presented to the respondents to indicate their level of awareness on sustainability practices

Table 4. Details of the interviewed respondents

S/N	Interviewee's designation	Interviewee's occupation	Duration of the interview	Interview method	Years of experience
Interviewee 1	Builder	Contractor (Public sector)	20	Face to face	17
Interviewee 2	Quantity Surveyor	Consultant (Private sector)	15	Face to face	10
Interviewee 3	Engineer	Consultant (Private sector)	17	Face to face	9
Interviewee 4	Architect	Consultant (Public sector)	22	Face to face	15
Interviewee 5	Architect	Client (Public sector)	14	Face to face	7
Interviewee 6	Builder	Contractor (Private sector)	21	Face to face	19
Interviewee 7	Engineer	Contractor (Public sector)	19	Face to face	8
Interviewee 8	Quantity Surveyor	Client (Private sector)	20	Face to face	11
Interviewee 9	Builder	Contractor (Public sector)	7	Phone	13

based on "yes", "no" and "not sure". Indicating "yes" implied that the respondents were fully aware of sustainability practices while "no" and "not sure" implied otherwise. Table 5 shows the awareness level of building professionals on sustainability practices during building projects. The analysis revealed that 66% of the respondents are aware of sustainability practices, while 21% did not have any idea and 13% were not sure of the practices. Furthermore, as shown in Table 5, the result also indicates that the majority of the building professionals are aware of sustainability practices as the awareness levels calculated for each of the practices are more than 0.5. The average awareness level for all the respondents was 0.657. This by implication means that the respondents are aware of major sustainability practices on building construction projects. Only a few practices have awareness level less than 0.5 and these are as follows: "provision of equal employment opportunities" with 0.488, "control of carbon emissions" with 0.363 awareness level, "use of noise barriers at site" with 0.35 awareness level and "use of vertical green wall at the site to cool the office" with 0.25 awareness level making them the least popular amongst the respondents. From this result, it can be deduced that the majority of construction professionals in the study area are aware of sustainability practices on building construction projects.

For hypothesis one, Kruskal–Wallis test was performed to ascertain whether or not there is variation in the responses amongst the construction professionals (Architects, Builders, Engineers and Quantity Surveyors) regarding their awareness level of sustainability practices in the study area. As presented in Table 6, since the majority of the variables show a p-value greater than 0.05 which by implication means there are no significant variation. As such, the null hypothesis is accepted, while the alternative hypothesis is rejected for them. Only three variables are with p-values less than 0.05, which by implication means that there is significant variation in the perceptions of construction professionals. Those variables are "control of dust to reduce pollution on building" with a p-value of 0.011, "waste management for solid excavated materials" with a p-value of 0.012 and "participatory approach by involving stakeholders" with a p-value of 0.036. For them, the null hypothesis is rejected and the alternative hypothesis is accepted. In a bid to determine the source of variation amongst the construction professionals, a *post hoc* test was conducted for the three variables. The

S/N	Sustainability practices	*N*	Frequency of response: Yes Freq	Yes %	No Freq	No %	Not sure Freq	Not sure %	AL
1	Choosing the right construction method for resource conservation	80	76	95	2	2.5	2	2.5	0.95
2	Consideration of the client's satisfaction	80	76	95	2	2.5	2	2.5	0.95
3	Control of water usage	80	67	84	9	11.3	4	5	0.838
4	Promotion of community development and local source of material	80	65	81.3	9	11.3	6	7.5	0.813
5	Sustainable site planning and innovation	80	63	79	10	13	7	8.8	0.788
6	Use of formwork systems to reduce the use of timber	80	62	78	10	13	8	10	0.775
7	Controlling the use and dispersion of toxic materials	80	50	63	12	15	18	23	0.625
8	Use of life cycle costing in building projects	80	57	71.3	14	18	9	11.3	0.713
9	Waste management for solid excavated materials	80	54	68	14	18	12	15	0.675
10	Considering the impact of projects on air, soil and water	80	54	68	15	19	11	14	0.675
11	Recycling and reuse of materials	80	54	68	15	19	11	14	0.675
12	Participatory approach by involving stakeholders	80	49	61.3	14	18	17	21.3	0.613
13	Employment and retention of labour	80	59	74	18	23	3	3.8	0.738
14	Indoor environmental quality	80	52	65	16	20	12	15	0.65
15	Use of renewable materials	80	52	65	16	20	12	15	0.65
16	Control of dust to reduce pollution on building	80	56	70	19	24	5	6.3	0.7
17	Use of environmentally friendly cleaning products and pesticides on sites	80	48	60	20	25	12	15	0.6
18	Use of alternative energy sources or devices for energy savings	80	46	58	22	28	12	15	0.575
19	Provision of equal employment opportunities	80	39	49	25	31.3	16	20	0.488
20	Control of carbon emissions	80	29	36.3	38	48	13	16.3	0.363
21	Use of noise barriers at site	80	28	35	39	49	13	16.3	0.35
22	Use of vertical green wall at the site to cool the office	80	20	25	37	46.3	23	29	0.25
	Average awareness level			66		21		13	0.657

Note(s): *N* = Frequency; AL = Awareness level

Table 5.
Awareness level of sustainability practices

result as shown in Table 7 reveals that the source of variation for both the "control of dust to reduce pollution on building" and "participatory approach by involving stakeholders" emanated from the perception of the Architects, while the source of variation for "waste management for solid excavated materials" was actually from the perception of the Builders.

Level of awareness	Designation of the respondents	N	Mean rank	χ^2	D/F	Sign	Remark
Recycling and reuse of materials	Builder	17	33.59	3.476	3	0.324	NS
	Architect	13	42.12				
	Engineer	28	40.45				
	Quantity Surveyor	22	44.95				
Control of dust to reduce pollution on building	Builder	17	37.32	11.181	3	0.011	S
	Architect	13	54.46				
	Engineer	28	34.29				
	Quantity Surveyor	22	42.61				
Control of water usage	Builder	17	38.85	6.558	3	0.087	NS
	Architect	13	34.00				
	Engineer	28	39.66				
	Quantity Surveyor	22	46.68				
Control of carbon emissions	Builder	17	30.29	5.470	3	0.140	NS
	Architect	13	42.12				
	Engineer	28	41.71				
	Quantity Surveyor	22	45.89				
Use of alternative energy sources or devices for energy savings	Builder	17	42.50	2.519	3	0.472	NS
	Architect	13	39.19				
	Engineer	28	36.25				
	Quantity Surveyor	22	45.14				
Choosing the right construction method for resource conservation	Builder	17	38.50	5.382	3	0.146	NS
	Architect	13	44.81				
	Engineer	28	41.29				
	Quantity Surveyor	22	38.50				
Use of formwork systems to reduce the use of timber	Builder	17	38.91	3.061	3	0.382	NS
	Architect	13	45.35				
	Engineer	28	36.96				
	Quantity Surveyor	22	43.36				
Use of environmentally friendly cleaning product and pesticides on site	Builder	17	39.21	1.889	3	0.596	NS
	Architect	13	34.96				
	Engineer	28	40.71				
	Quantity Surveyor	22	44.50				
Sustainable site planning and innovation	Builder	17	38.44	2.357	3	0.502	NS
	Architect	13	35.46				
	Engineer	28	43.34				
	Quantity Surveyor	22	41.45				
Use of noise barriers at site	Builder	17	43.82	0.728	3	0.867	NS
	Architect	13	40.27				
	Engineer	28	38.29				
	Quantity Surveyor	22	40.89				
Use of vertical green wall at the site to cool the office	Builder	17	34.24	3.192	3	0.363	NS
	Architect	13	46.15				
	Engineer	28	43.61				
	Quantity Surveyor	22	38.05				
Waste management for solid excavated materials	Builder	17	27.50	11.036	3	0.012	S
	Architect	13	48.81				
	Engineer	28	43.64				
	Quantity Surveyor	22	41.64				

Table 6.
Perception on the level of awareness of sustainability practices amongst construction professionals

(*continued*)

Level of awareness	Designation of the respondents	N	Mean rank	χ^2	D/F	Sign	Remark
Indoor environmental quality	Builder	17	31.32	5.968	3	0.113	NS
	Architect	13	37.58				
	Engineer	28	44.07				
	Quantity Surveyor	22	44.77				
Controlling the use and dispersion of toxic materials	Builder	17	33.68	7.424	3	0.060	NS
	Architect	13	50.35				
	Engineer	28	36.46				
	Quantity Surveyor	22	45.09				
Considering the impact of project on air, soil and water	Builder	17	36.38	4.265	3	0.234	NS
	Architect	13	49.08				
	Engineer	28	37.52				
	Quantity Surveyor	22	42.41				
Use of renewable materials	Builder	17	33.32	7.007	3	0.072	NS
	Architect	13	32.81				
	Engineer	28	46.00				
	Quantity Surveyor	22	43.59				
Use of life cycle costing in building projects	Builder	17	42.88	2.684	3	0.443	NS
	Architect	13	38.08				
	Engineer	28	43.73				
	Quantity Surveyor	22	35.98				
Consideration of the client's satisfaction	Builder	17	38.50	5.205	3	0.157	NS
	Architect	13	44.65				
	Engineer	28	41.36				
	Quantity Surveyor	22	38.50				
Employment and retention of labour	Builder	17	47.09	6.191	3	0.103	NS
	Architect	13	33.77				
	Engineer	28	36.88				
	Quantity Surveyor	22	44.00				
Participatory approach by involving stakeholders	Builder	17	35.15	8.566	3	0.036	S
	Architect	13	55.15				
	Engineer	28	39.04				
	Quantity Surveyor	22	37.84				
Provision of equal employment opportunities	Builder	17	39.88	0.730	3	0.866	NS
	Architect	13	37.23				
	Engineer	28	43.00				
	Quantity Surveyor	22	39.73				
Promotion of community development and local source of material	Builder	17	40.41	4.394	3	0.222	NS
	Architect	13	33.00				
	Engineer	28	44.11				
	Quantity Surveyor	22	40.41				

Table 6.

4.3 Level of implementation of sustainability practices during building construction projects

4.3.1 Level of sustainability practices implementation based on different professionals. In this section, the already identified and piloted 22 sustainability practices variables were given to the respondents to rate the level to which they are being implemented during building construction projects based on their experience using a Likert point scale of 1–5, where 1 represents very low and 5 represents very high. The results presented in Figure 2 indicate that overall "consideration of the client's satisfaction" is ranked the highest sustainability practices being implemented in the study area with an MIS of 4.39. This is followed by "choosing the right construction method for resource conservation" with an MIS of 4.21 ranked second, then the "provision of equal employment opportunities" ranked third with an MIS of 3.96. The "promotion of community development and local source of materials"

Level of awareness	Designation of the respondents	Mean rank	Sign
Control of dust to reduce pollution on building	Builder	12.53	0.014
	Architect	19.38	
	Builder	24.18	0.481
	Engineer	22.29	
	Builder	18.62	0.399
	Quantity Surveyor	21.07	
	Architect	28.35	0.001
	Engineer	17.59	
	Architect	20.73	0.175
	Quantity Surveyor	16.39	
	Engineer	23.41	0.114
	Quantity Surveyor	28.16	
Waste management for solid excavated materials	Builder	12.00	0.001
	Architect	20.08	
	Builder	17.50	0.004
	Engineer	26.34	
	Builder	16.00	0.006
	Quantity Surveyor	23.09	
	Architect	22.69	0.492
	Engineer	20.21	
	Architect	20.04	0.309
	Quantity Surveyor	16.80	
	Engineer	26.09	0.709
	Quantity Surveyor	24.75	
Participatory approach by involving stakeholders	Builder	12.50	0.001
	Architect	19.42	
	Builder	21.41	0.448
	Engineer	23.96	
	Builder	19.24	0.641
	Quantity Surveyor	20.59	
	Architect	27.12	0.015
	Engineer	18.16	
	Architect	22.62	0.023
	Quantity Surveyor	15.27	
	Engineer	25.91	0.792
	Quantity Surveyor	24.98	

Table 7.
Post hoc test on perception of the level of awareness of sustainability practices amongst construction professionals

ranked fourth with an MIS of 3.75, while the "control of water usage" was ranked fifth with an MIS of 3.74. The results as shown in Figure 2 indicate that majority of the variables had an MIS of greater than 3.00, which by implication means that the level of implementation of sustainability practices in building construction projects is relatively high in the study area. This shows that, to some extent, the awareness of sustainability practices as revealed in the preceding section has translated into implementation based on the perception expressed by the professionals surveyed. However, it is yet unclear whether or not the awareness and implementation levels have translated into actual practice on building construction sites. This will be explored in detail in Section 4.4 of this paper based on an in-depth conducted.

There is, however, the need to disaggregate the results based on different professionals who participated in the study. The first five most ranked sustainability practices by all professionals were subjected to further analysis as shown in Figure 3. The first five most ranked practices were selected mainly for ease analysis and to clearly present the insights from the data in terms of the profession(s) driving the implementation of sustainability

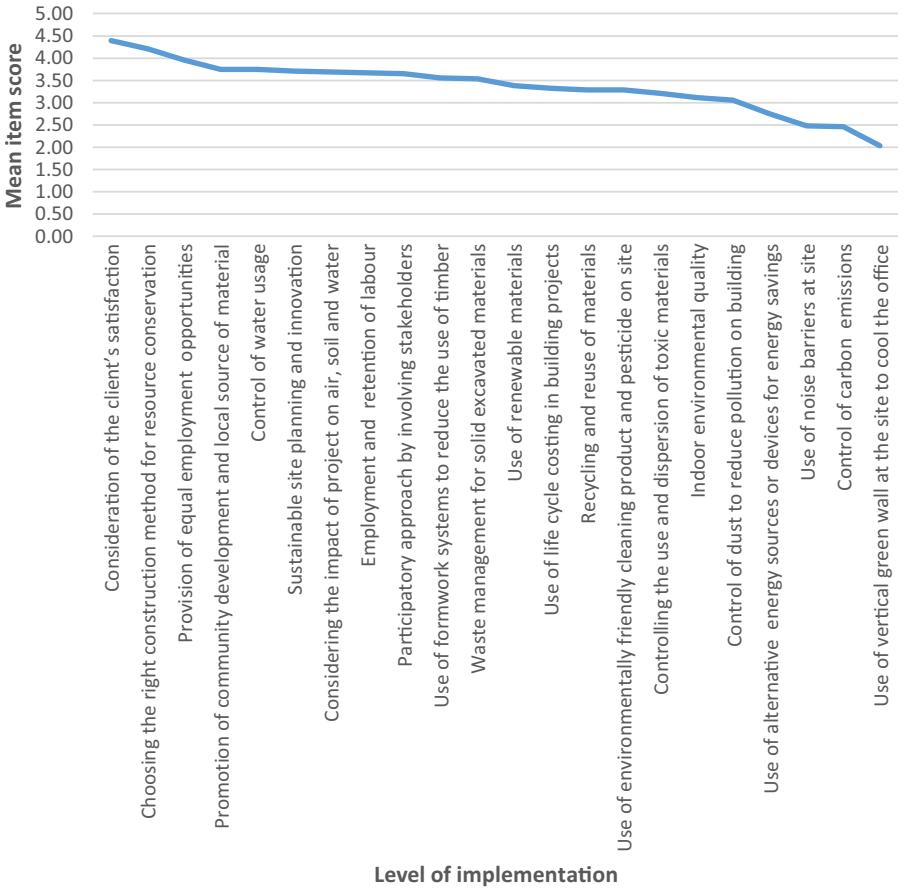


Figure 2.
Results of the implementation level of sustainability practices during building construction projects

practices. From Figure 3, it is evident that Builders whose responsibility is the physical implementation of building construction projects in Nigeria considered "consideration of the client's satisfaction", "choosing the right construction method for resource conservation", "provision of equal employment opportunities", "promotion of community development and local source of materials" and "control of water usage" in that order as the most sustainability practices being implemented on building construction sites. Further insight from the result in Figure 3 suggests that Engineers (civil/structural), whose input to any building construction projects in Nigeria are restricted to mainly the structural design, agree with the perception of Builders regarding the sustainability practices being implemented. However, the difference in the two professionals' rankings is that Engineers ranked the "control of water usage" more than "promotion of community development and local source of materials" while Builders ranked the "promotion of community development and local source of materials" more than the "control of water usage". Further to above, there is the homogeneity of opinions when compared the perception of Quantity Surveyors to that of Builders and Engineers. The difference(s) is located in the area where the Quantity Surveyors ranked the "promotion of community development and local source of materials" more than the "provision of equal employment opportunities". However, the thoughts of the Architects slightly differ from the

rest of the professionals in the order of ranking. Importantly, all professionals ranked the first five practices identified in Figure 3 as the five most ranked sustainability practices being implemented on building construction sites in Nigeria. The question yet unanswered revolves round the actual implementation of those sustainability practices as expressed by the building professionals based on their perceptions. Also, which of the professionals driving the actual implementation of sustainability practices on building construction sites? As previously opined, these will be further explored in Section 4.4 of this paper.

Statistically, there is a need to explore the variation in the opinions of the professionals. As such, Table 8 presents the results of the second hypothesis regarding the perception of construction professionals on the level of implementation of sustainability practices in building construction projects in the study area for the five most ranked practices from the fore. Since the *p*-values of two variables out of five were greater than 0.05, the null hypothesis was accepted, while the alternative hypothesis was rejected implying that they are not significant. The remaining three variables showed *p*-values of less than 0.05. This by implication means that the null hypothesis was rejected and the alternative hypothesis was accepted. For those three variables that were significant, it means that there is a significant variation in the perception of construction professionals. As such, there is the need to trace the source of the variation. Therefore, there is a need to conduct a post hoc test.

The results from the post hoc test is shown in Table 9. The results reveal that for the "control of water usage" and "provision of equal employment opportunities", the source of the variation came from the perception of the Architects, while the source of variation for "choosing the right construction method for resource conservation" was traced to Builders and Architects. This clearly validates the results as presented in Figure 1 showing the opinions of Architects differing slightly from those of other construction professionals surveyed based on the order of rankings.

4.3.2 Level of sustainability practices implementation based on regional differences. As explained in Section 3 (methodology section) of this paper, the survey was conducted in such a way to cover all geopolitical zones in Nigeria in order to highlight the regional differences in

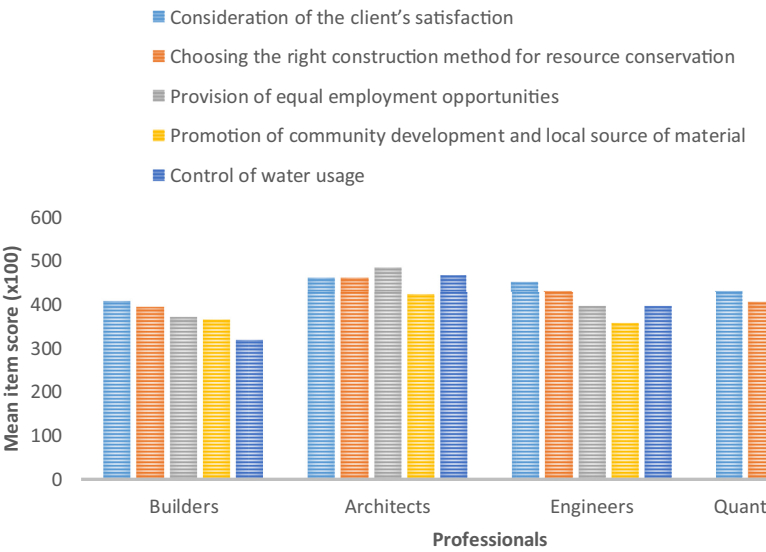


Figure 3.
Level of implementing sustainability practices by professionals

Level of implementation	Designation of the respondents	N	Mean rank	χ^2	D/F	Sign	Remark
Control of water usage	Builder	17	30.38	16.584	3	0.001	S
	Architect	13	60.15				
	Engineer	28	43.46				
	Quantity Surveyor	22	32.93				
Choosing the right construction method for resource conservation	Builder	17	32.06	8.361	3	0.039	S
	Architect	13	51.46				
	Engineer	28	44.71				
	Quantity Surveyor	22	35.18				
Consideration of the client's satisfaction	Builder	17	31.24	6.597	3	0.086	NS
	Architect	13	48.58				
	Engineer	28	44.43				
	Quantity Surveyor	22	37.89				
Provision of equal employment opportunities	Builder	17	33.79	15.438	3	0.001	S
	Architect	13	60.62				
	Engineer	28	41.59				
	Quantity Surveyor	22	32.41				
Promotion of community development and local source of materials	Builder	17	34.97	5.380	3	0.146	NS
	Architect	13	51.62				
	Engineer	28	37.04				
	Quantity Surveyor	22	42.61				

Table 8.
Perception on the level of implementation of sustainability practices amongst construction professionals

the results. Figure 4 illustrates this. The pattern of the results as shown in Figure 4 suggests a similar pattern in the results obtained from the South–South, North East and to some extent South–East geopolitical zones of Nigeria. The three zones ranked the "provision of equal employment opportunities" as the most sustainability practice being implemented in the zones. This insight is significant and profound in the sense that over the years, the South–South zone has witnessed a high level of youth unrest due to the activities of oil exploration which have ravaged the region. As such, there is abject poverty in the land. For building construction projects to be executed successfully, there is the need to have a clear roadmap regarding equitable employment of arrant youths in the zone. This then explains why the "provision of equal employment opportunities" was ranked most. Similarly, the result from the North East is unsurprising because the region is also ravaged with a high level of poverty because of *Boko Haram* insurgency which has destroyed the region. Hence, the clamour for employment by the youths in the zone.

Other results are as presented in Figure 4. Importantly, the pattern of the results from the South West, North Central, North West and to some extent from the FCT are similar. The "consideration of the client's satisfaction" is the most implemented sustainability practice in the South West, North Central and North West based on the perception of the construction professionals in the zones except for FCT which "choosing the right construction method for resource conservation" was ranked most. However, the FCT professionals ranked the "consideration of the client's satisfaction;" second, while the professionals from the South West and North Central zones ranked "choosing the right construction method for resource conservation" second. Similarly, the professionals in the remaining zones ranked both the "consideration of the client's satisfaction" and "choosing the right construction method for resource conservation" very high. Besides the insights from the fore, it is clear that that there is the homogeneity of perceptions from the professionals in different geopolitical zones in Nigeria regarding the top five sustainability practices being implemented in Nigeria.

Level of implementation	Designation of the respondents	Mean rank	Sign
Control of water usage	Builder	10.97	0.001
	Architect	21.42	
	Builder	18.06	0.040
	Engineer	26.00	
	Builder	19.35	0.748
	Quantity Surveyor	20.50	
	Architect	27.77	0.008
	Engineer	17.86	
	Architect	24.96	0.001
	Quantity Surveyor	13.89	
	Engineer	28.61	0.077
	Quantity Surveyor	21.55	
Choosing the right construction method for resource conservation	Builder	12.32	0.015
	Architect	19.65	
	Builder	18.56	0.057
	Engineer	25.70	
	Builder	19.18	0.671
	Quantity Surveyor	20.64	
	Architect	23.35	0.331
	Engineer	19.91	
	Architect	22.46	0.032
	Quantity Surveyor	15.36	
	Engineer	28.11	0.125
	Quantity Surveyor	22.18	
Provision of equal employment opportunities	Builder	11.12	0.001
	Architect	21.23	
	Builder	20.18	0.237
	Engineer	24.71	
	Builder	20.50	0.800
	Quantity Surveyor	19.61	
	Architect	27.81	0.006
	Engineer	17.84	
	Architect	25.58	0.000
	Quantity Surveyor	13.52	
	Engineer	28.04	0.146
	Quantity Surveyor	22.27	

Table 9.
Post hoc test on perception of the level of implementation of sustainability practices amongst construction professionals

4.4 The actual level of implementation of sustainability practices on building projects

It is important to gain further insights into the level of implementation of sustainability practices on building construction projects. The questions about the level of implementation of sustainability practices on building construction projects were posed to the interviewees in a general manner before going specific. Based on the content analysis of the transcribed digital recordings regarding the sustainability practices being implemented on their building construction projects, the first interviewee stated that "*with your explanation of sustainability practices, I think we engage in some sustainability practices unconsciously on the projects we are currently working on without actually knowing that we are doing them*". Interviewee 2 specifically mentioned that planting trees and grasses on site are part of the sustainability practices that were implemented on site. Interviewee 3 mentioned that health and safety management/best practice was implemented on building construction projects. The view of interviewee 4 was that extensive allowance for green areas and trees, as opposed to hard stands and pavements, are carried out when executing building projects. While interviewee 5

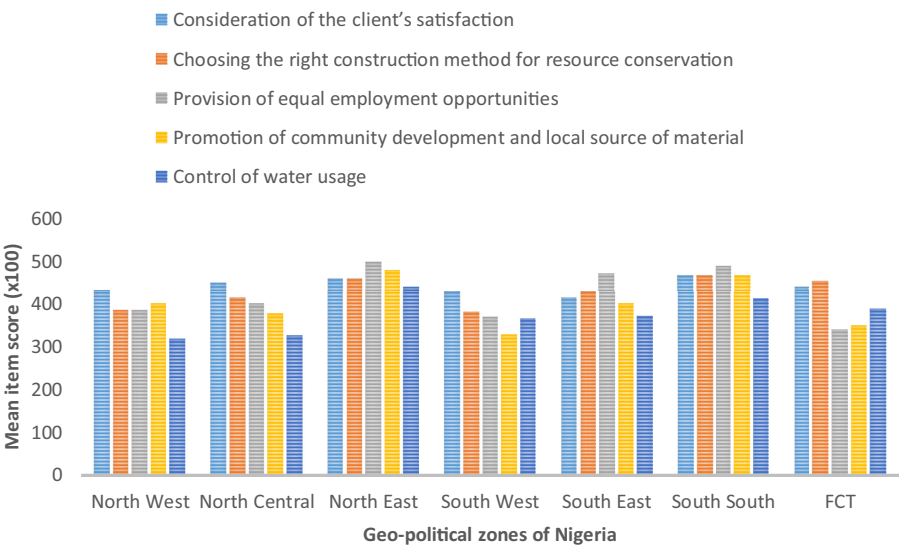


Figure 4.
Level of implementing sustainability practices based on geopolitical zones in Nigeria

stressed more on the need to carry out community development project to impact the environment. Interviewees 6 and 7 agreed with interviewees 2 and 4 on planting ornamental plant and grass for landscaping purposes. Interviewee 8 thought that the use of toxic materials should be reduced during construction and interviewee 9 mentioned the use of steel/panel formwork systems to reduce the use of timber as other sustainability practices implemented on building construction projects. All of the interviewees acknowledged that sustainability practices are being implemented during building construction projects, though interviewee 1 specifically mentioned that it is done subconsciously.

Specifically, the findings from the questionnaire survey were posed to the interviewees in order to establish the actual implementation of sustainability practices on their respective building construction projects. The identified five most ranked sustainability practices were put to them as questions and they were asked to support their responses with reasons. The insights from the interviews suggest that all interviewees confirmed that "choosing the right construction method for resource conservation" is one of the focal points during the bidding process for the building construction projects they have participated in. As such, they must implement same on their projects. Some of the interviewees added that implementing this practice not only add value to their operations but also create a kind of competitive advantage to their respective companies. Regarding the "consideration of the client's satisfaction" as one of the sustainability practices being implemented on building construction sites, it was in one voice that all interviewees echoed their confirmation of the actual implementation of this practice. Some of them added that any construction company that wants to kick itself out of jobs will fail to implement this practice. One of the interviewees (interviewee 8) opined that of their top sustainability priorities in their company is that of client satisfaction, which invariably allows them to control a substantial part of the market share. The interviewees, however, presented divergent views regarding the actual implementation of the remaining three sustainability practices in their respective companies. While some of them confirmed that they implement the "promotion of community development and local source of materials" and "provision of equal employment opportunities" as part of their corporate social responsibility, others reported that they are unsure of the actual implementation of them. However, they all confirmed the best building construction practice is driving their

actual implementation of some sustainability practices, especially "choosing the right construction method for resource conservation".

4.5 Discussion of results

For the purpose of examining the level of awareness of sustainability practices during the construction phase of building projects amongst construction professionals in Nigeria, respondents were asked to rate their level of awareness of sustainability practices based on their knowledge. The result of the study revealed that "choosing the right construction method for resource conservation" and "consideration of the client's satisfaction" was the major sustainability practices that the respondents are aware of. Others were "control of water usage", "promotion of community development and local source of material", "sustainable site planning and innovation" and "use of formwork systems to reduce the use of timber". This indicates that construction professionals in Nigeria are aware of the environmental, economic and social aspects of sustainability. The result agrees with the findings of Rahim *et al.* (2014) that sustainability principle is based not only on the pillars of environmental but also on economic and social pillars. On the other hand, this result is contrary to previous research by Abolore (2012) and Dania *et al.* (2013) conducted in Lagos and Abuja, respectively, that the understanding and awareness level of sustainability issues amongst practising professionals is low and deficient. This may be because 2012 and 2013 were long enough to raise the awareness level. As such, the findings of this research have theoretically proved that construction professionals in Nigeria are aware of sustainability practices during building construction projects at the moment.

Results from the hypothesis on the perception of construction professionals regarding the level of awareness of sustainability practices in Nigeria reveal that the p-values of 19 variables were not statistically significant meaning that there is no significant variation in the opinions of construction professionals. However, only three variables had p-values of less than 0.05 meaning that there is a significant variation in their opinions. Those variables are "control of dust to reduce pollution on building", "waste management for solid excavated materials" and "participatory approach by involving stakeholders". The source of the variation was traced by conducting a post hoc test which reveals that Architects are the source for "control of dust to reduce pollution on building" and "participatory approach by involving stakeholders", while builders are responsible for the source of variation in "waste management for solid excavated materials".

On the level of implementation of sustainability practices, the "consideration of the client's satisfaction" was investigated to be the highest sustainability practices being implemented during the construction phase of building projects in the study area. This is followed by "choosing the right construction method for resource conservation", "provision of equal employment opportunities", "promotion of community development and local source of materials" and "control of water usage" as sustainability practices being implemented during the building construction projects in the study area. This was an indication that the level of implementation of the economic aspect of sustainability practices in building construction projects is high in the study area with almost all the variables having an MIS score of more than 3.00. This result is therefore in agreement with Presley and Meade (2010) and Ochieng *et al.* (2014) who asserted that client's satisfaction is a sustainability indicator at the project level as construction clients are increasingly requiring business consultants, contractors and suppliers to adopt sustainability policies in the construction process. Also, the result supports the assertion of Abolore (2012) and Ochieng *et al.* (2014) that the practical implementation and integration of sustainability principles (economic, social and environmental) into construction projects is significant to manage the current environmental issue and attain significant improvements in performance and improve project delivery. The findings from

the study also indicated that the following sustainability practices are yet to gain momentum on building construction sites in Nigeria: the "use of alternative energy sources or devices for energy savings", "use of noise barriers at site", "control of carbon emissions" and "use of vertical green wall at the site to cool the office". This may be some of the areas the Nigerian Government will have to engage with considering the fact that Nigeria is one of the signatories to the Paris accord of 2015 on climate change effects.

5. Conclusion and recommendations

Construction activities during building projects will continue to negatively impact the environment unless the concept of sustainability is fully implemented on building projects. This paper has provided meaningful insights into sustainability practices that can be implemented in building projects for improved performance, resource efficiency and environmental conservation. The study examined the level of awareness of sustainability practices and investigated the level of implementation of these practices during building construction projects.

Findings revealed that the awareness level of sustainability practices is high in the study area with "choosing the right construction method for resource conservation" and "consideration of the client's satisfaction" are the two major sustainability practices that construction professionals are aware of. The findings regarding the test of a hypothesis performed to ascertain whether or not there is variation in the responses of construction professionals on their awareness level of sustainability practices reveal that there is no variation in 19 of sustainability practices identified except for three, which are "control of dust to reduce pollution on building", "waste management for solid excavated materials" and "participatory approach by involving stakeholders". The source of variation was explored and discovered that the source of variation for both "control of dust to reduce pollution on building" and "participatory approach by involving stakeholders" came from the Architect, while that of "waste management for solid excavated materials" was from the Builder.

Further findings from the study revealed that the "consideration of the client's satisfaction" was adjudged by the professionals to be the highest sustainability practices being implemented during the construction phase of building projects; "choosing the right construction method for resource conservation", "provision of equal employment opportunities", "promotion of community development and local source of materials" and "control of water usage" were other sustainability practices implemented during building construction projects. However, the following sustainability practices are least implemented on building construction sites "use of alternative energy sources or devices for energy savings", "use of noise barriers at site", "control of carbon emissions" and "use of vertical green wall at the site to cool the office". Variation on the perception of construction professionals on the level of implementation of sustainability practices was explored again. The findings recorded no significant variation in two variables, while significant variation occurred in three variables when the top five most ranked practices were further explored. The source of the variation was also traced to Architects perceptions. The regional differences were also explored in order to see the effects of different geopolitical zones in the implementation of sustainability practices.

The study concluded that the awareness level of sustainability practices is now high in Nigeria. As such, the study concluded that construction professionals in Nigeria are now very much aware of the environmental, economic and social aspects of sustainability relating to building construction projects. Additionally, the study also concluded that some aspects of sustainability practices are being implemented on building construction projects in Nigeria. One of the most profound insights from the study is that the "consideration of the client's satisfaction" and "choosing the right construction method for resource conservation" are the

most actually implemented sustainability practices in the study. Besides those that are being implemented the study concludes that the following sustainability practices on building construction projects are yet to gain momentum in Nigeria: the "use of alternative energy sources or devices for energy savings", "use of noise barriers at site", "control of carbon emissions" and "use of vertical green wall at the site to cool the office".

Therefore, it is recommended that the construction professionals should further improve their knowledge of sustainability to enhance their competence in executing sustainable building construction projects. Public awareness on sustainability practices should be carried out by academicians, professional bodies and the government through seminars, workshops, conferences and training in Nigeria to increase civic consciousness on the benefits of applying sustainability practices during building construction projects. Also, it is important to increase the teaching hours of sustainable construction classes at higher education level, especially in the departments of Architecture, Building, Civil Engineering and Quantity Surveying. Besides, the necessary legal framework for sustainable building construction should evolve to give the legal backing to the concept of sustainable construction in Nigeria.

It is worthy of note that a study of this nature will have some strengths as well as some limitations. The main strength of this paper lies in the meaningful insights generated regarding the sustainability practices of building construction projects in Nigeria. However, there are some limitations to the study in this paper. The main limitation of the study is the small sample size. Further study is therefore needed with increased sample size in order to appropriately cater for the diversity of Nigeria as a country for more generalisation of the findings.

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